Perceptual biases and metacognition and their association with anomalous self experiences in first episode psychosis

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Perceptual biases and metacognition and their association with anomalous self experiences in First Episode Psychosis.

Dr Abigail Wright* [a b c], Professor Barnaby Nelson[d e] , Professor David Fowler [b c], Professor Kathryn Greenwood [b c] .

[a] *Center of Excellence for Psychosocial & Systemic Research, Massachusetts General Hospital*

[b] *University of Sussex, School of Psychology, Brighton, East Sussex, United Kingdom*

[c] *Sussex Partnership NHS Foundation Trust, Swandean, West Sussex, United Kingdom*

[d] *Orygen, The National Centre of Excellence in Youth Mental Health, Melbourne, Australia*

[e] *The Centre for Youth Mental Health, University of Melbourne, Melbourne, Australia*

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**corresponding author*:

Abigail Wright

Massachusetts General Hospital

Center of Excellence for Psychosocial & Systemic Research

151 Merrimac St. | 6th Floor | Boston, MA 02114

Email: awright24@mgh.harvard.edu

Abstract

Anomalous self-experiences have been described as a prerequisite for anomalous perceptual experiences. Later, these anomalous perceptual experiences may then be metacognitively appraised as distressing, maintaining these experiences and later leading to anomalous (delusional) beliefs. This model of anomalous events may potentially be driven by perceptual biases and metacognitive deficits. This cross-sectional study explored the association between perceptual biases, metacognition and anomalous self- and perceptual experiences and delusional beliefs in First Episode Psychosis (FEP) and a matched healthy control sample. Fifty-eight individuals with FEP and seventy-two healthy controls were included in the main analysis. Increased auditory perceptual biases were significantly associated with increased state and trait anomalous self-experiences, in particular alienation from surroundings and emotional numbing. No significant associations were found between metacognitive efficiency and anomalous experiences. These findings may be consistent with the minimal self-disturbance model of schizophrenia spectrum vulnerability, particularly with the hyperreflexivity concept.

Key words: First Episode Psychosis; anomalous experiences; dissociation; perceptual biases; metacognition

1. Introduction

Anomalous experiences refer to a rich variety of psychic phenomena. These experiences can be divided into three (somewhat overlapping) categories: anomalous self-experiences (distortions in experience of self and being); anomalous perceptual experiences (distortions of sensory events); and anomalous (delusional) beliefs (unusual thoughts or beliefs). Anomalous self-experiences may precede and generate anomalous perceptual experiences (hallucinations) (Nelson, Parnas, & Sass, 2014; Nelson & Raballo, 2015; Raballo, 2012, 2017) and anomalous (delusional) beliefs may develop from anomalous perceptual experiences (Corlett, Frith, & Fletcher, 2009; Fletcher & Frith, 2009). These experiences/beliefs may be common within the general population (Bell, Halligan, & Ellis, 2006; Kelleher et al., 2012) but their intensity and/or frequency is increased in those with psychotic or other mental disorders (Brett, Johns, Peters, & McGuire, 2009; Reininghaus et al., 2016; Yung, Phillips, Yuen, & McGorry, 2004). Therefore, understanding the cause of such experiences may be important for understanding factors that drive the onset of psychosis.

Studies have suggested anomalous self-experiences may be explained by the following factors: perceptual biases (Varese, Barkus, & Bentall, 2011), e.g. perceiving a stimulus (a voice) as present when it was absent; source-monitoring deficits (Nelson, Whitford, Lavoie, & Sass, 2014b) e.g. difficulties in the internal monitoring system (Frith, 1987; Frith 1992; Blakemore et al. 1999); and aberrant salience (Nelson, Whitford, Lavoie, & Sass, 2014a) e.g. difficulty in failing to suppress attention to irrelevant information (Hemsley, 1993). Aberrant salience may, at times, lead to perceptual biases, which have been tested using signal detection theory (SDT). SDT studies have demonstrated that anomalous experiences are associated with perceptual signal detection biases (Barkus et al., 2010; Bentall & Slade, 1985; Kok, Kouider, Lange, & Supe, 2015; Mussgay & Hertwig, 1990). These studies highlight that those with psychosis have a lower threshold for recognizing a stimulus as present (Moritz, Woodward, Jelinek, & Klinge, 2008; Moritz et al., 2017; Veckenstedt et al., 2011), which has recently been associated with aberrant salience in vivo using experience sampling methodology (Reininghaus et al., 2018).

Together, these neurocognitive factors (aberrant salience, source-monitoring deficits, and perceptual biases) may contribute to i) diminished self-presence, i.e. a weakened sense of existing as a *subject* of awareness and ii) hyperreflexivity, i.e. a heightened awareness of aspects of experience that are normally implicit (Nelson et al., 2014a; Nelson et al., 2014b).

This has been recently described in a bio-pheno-social model of anomalous self-experiences (Sass, Borda, Madeira, Pienkos, & Nelson, 2018). This model suggests the role of "primary" hyper-reflexivity or diminished self-presence, as a result of salience/bias, can undermine an individual's sense of being grounded within a shared world and is likely to alienate the self, possibly leading to an array of "secondary" anomalous self-experiences (varieties of depersonalisation, disturbances in stream of consciousness, distorted bodily experiences and existential reorientation) (Nelson, Sass, & Škodlar, 2009; Sass & Parnas, 2017). As a result of the perceptual biases and diminished self-presence/hyperreflexivity, an individual overly focuses on (generally implicit) bodily sensations (*anomalous bodily experiences*) and may find it difficult to make sense of their surroundings or previous events as there is an overload of information (*alienation from surroundings; anomalous subjective recall*) and may downregulate emotional responsivity in order to prevent overstimulation or distress (*emotional numbing*) (Sierra, Baker, Medford, & David, 2005).

Anomalous self-experiences have been suggested to give rise to anomalous perceptual experiences (Nelson et al., 2014; Raballo, 2017; Raballo & Preti, 2018a). This is one route via which anomalous perceptual experiences develop (an another route is that aberrant perceptual experiences, e.g. perceptual organisation, contribute to disturbed self-experience (Uhlhaas & Mishara, 2007)), as the anomalous self-experiences become strengthened and thematized (Raballo, 2012; Raballo & Preti, 2018b). Hemsley (1993) described the presence of anomalous perceptual experience as a "weakening" of top-down influences, leading to a mismatch between top-down and bottom-up processing (Gray, 1995; John & Hemsley, 1992). Recently, predictive processing framework has suggested that, within psychosis, there is a weakening of the use of prior beliefs and overreliance on sensory occurrences (Sterzer et al., 2018). This loss of top-down predictions causes extra weight to be given to external influences which makes aspects in the environment become overly salient (Adams, Stephan, Brown, Frith, & Friston, 2013), which may explain the presence of perceptual biases. Auditory perceptual biases are more frequent within individuals with schizophrenia and hallucinations, compared to those with schizophrenia and no hallucinations (Varese, Barkus, & Bentall, 2012), suggesting a specific association with hallucinations. Therefore, anomalous perceptual experiences may be predicted by perceptual biases directly, or via anomalous self-experiences.

Recent research has begun to assess the role of metacognition within anomalous experiences. Metacognition is defined as "thinking about thinking" (Flavell, 1979; Semerari et al., 2003) or an appraisal of cognitive processes, self, abilities and experiences (Nelson & Narens, 1990). In particular, metacognitive sensitivity involves unconscious knowledge which generates a "feeling of knowing" or "knowing that you know" (Sherman et al., 2015). Metacognitive sensitivity can be assessed using a signal detection task, e.g. the participant must make a judgment of whether a visual stimulus (white dot) was present or absent within a noisy, moving picture, e.g. "Was the dot present or absent?". Then making a second judgment of confidence in relation to the first judgment, e.g. "Do you have high or low confidence?". This second measure can be used to calculate metacognitive sensitivity (meta-*d'*), which describes how closely matched confidence ratings are to correct vs incorrect trials. Metacognitive efficiency score is metacognitive sensitivity score divided by the objective task performance score (meta-*d'/d*) (Fleming & Lau, 2014). Within all theories of metacognition, whether at the perceptual level outlined above or an appraisal of bias or higher-order belief system, the metacognitive model infers that the person holds erroneous beliefs or thoughts about their cognitive processes (perceptions, appraisals or beliefs), which may impact on their experiences or, and functions within, the world.

Metacognition, assessed by within-task confidence ratings, has been shown to be significantly poorer in psychosis (Bliksted et al., 2017; Davies et al., 2018) and those with psychosis have a tendency to be overconfident in incorrect responses (metacognitive bias) (Gawęda, Moritz, & Kokoszka, 2012). These metacognitive deficits are present in those with a history of hallucinations (Gawęda, Mikuła, Szelenbaum, & Kokoszka, 2014) and those at high-risk (Gawęda et al., 2018), in such that those with hallucinations or psychotic experiences may be less able to understand these experiences and demonstrate a reduction in metacognitive confidence in these groups. However, this research has not been consistent (Gawęda et al., 2013). The inconsistencies in this area may be due to varying experimental controls across tasks, e.g. lack of control for objective performance, which is important to control in order to accurately assess metacognition. This lack of control may have impacted metacognitive efficiency scores (Balzan, Woodward, Delfabbro, & Moritz, 2016; Fleming & Lau, 2014). Importantly, perceptual ability and metacognition can be modality-specific abilities (Fleming, Ryu, Golfinos, & Blackmon, 2014; Morales, Lau, & Fleming, 2018) and anomalous perceptual experiences can occur across several modalities (see Mitchell et al., 2017). This suggests the possible role of metacognitive efficiency in anomalous experiences and, as experiences become more explicit or conscious, there may be potential for a modality-specific association.

Metacognitive difficulties may maintain the presence of anomalous perceptual experiences and, later, predict anomalous (delusional) beliefs. The hierarchical framework from anomalous perceptual experiences to anomalous delusional beliefs has been suggested by many theories (Corlett et al., 2009; Fletcher & Frith, 2009; Freeman, Garety, Kuipers, Fowler, & Bebbington, 2002). This may be connected via metacognition and, therefore, metacognition may also predict anomalous (delusional) beliefs (Cella, Swan, Medin, Reeder, & Wykes, 2014; Moritz et al., 2014; Moritz et al., 2015; Moritz, Woodward, & Moritz, 2006; Warman, 2008).

Integrating this research, we suggest that anomalous self- and perceptual experiences and delusional beliefs may be associated within a hierarchical framework. It is hypothesized that there is an indirect relationship between anomalous self-experience (within this study, depersonalization) and anomalous (delusional) belief, mediated by anomalous perceptual experiences. Next, anomalous self- and perceptual experiences may be predicted by perceptual biases (and hyperreflexivity) and metacognitive efficiency. Through this hierarchical framework, metacognition may also predict anomalous (delusional) beliefs (see figure 1). As experiences become more explicit, it is hypothesized that there is a modality-specific association; visual perceptual biases and metacognitive efficiency may be associated with anomalous visual experiences, and vice versa for auditory modality.

[INSERT FIGURE 1]

2. Methods

2.1 Design

This present study involved a cross-sectional design with experimental tasks and questionnaires to investigate the association between perceptual biases, metacognition and anomalous self- experiences, anomalous perceptual experiences, and delusional experiences in FEP and healthy controls matched on age, gender and education level.

2.2 Procedure

All participants provided informed consent to take part. Participants were asked to complete two signal detection tasks, counterbalanced between participants. Protocol can be reviewed in Wright, Fowler and Greenwood (2018). All measures were completed by the first author, supported by weekly supervision with a clinical psychologist. The first author was trained to use and score all the measures and demonstrated acceptable inter-rater reliability, according to agreed definitions with an experienced clinician.

2.3 Participants

Individuals with psychosis (18 years old and over) were recruited through a convenience sample from Early Intervention in Psychosis services in Sussex Partnership NHS Foundation Trust, and a minority were re-recruited from a previous first episode psychosis (FEP) sample (Davies, Fowler, & Greenwood, 2017). Seventy-seven participants were recontacted from a previous FEP cohort study (Davies, Fowler & Greenwood, 2017) of whom 29 agreed to take part in the current and a longitudinal study (Wright, Davies, Fowler & Greenwood, 2019). These participants were complemented by new FEP participants. There were no differences in symptoms, general functioning, metacognition or IQ between those newly recruited into the study compared to those recruited from the previous FEP study. All participants had been engaged in the Early Intervention Service (EIS) for at least 3 months prior to participating in the study and were reported by a psychiatrist in EIS as presenting with first episode of psychosis (F29), including both affective and non-affective psychosis. Participants with primary diagnoses of substance misuse disorder or organic neurological impairment were excluded. Healthy control participants were recruited as a comparison group, matched with the clinical group on age and gender (Table 1 provides information on difference statistics). Participants with current mental health problems or family history of psychosis were excluded if they responded yes, to any of the following: currently experiencing mental health difficulties; on any psychotropic medication/substances; in contact with psychological or psychiatric services for psychological problems; immediate family member (parent/sibling) experienced an episode of psychosis. Data collection was undertaken between March 2017 and May 2018.

2.4 Measures

2.4.1 Anomalous experience measures

Anomalous self-experiences: Cambridge Depersonalisation Scale (trait and state versions) (Sierra & Berrios, 2000). The trait version includes 29 items assessing anomalous self-experiences over the last 6 months, with 4 suggested subscales: ‘alienation from surroundings’, ‘anomalous subjective recall’, ‘emotional numbing’ and ‘anomalous body experience’ (Sierra et al., 2005). For example: “Out of the blue, I feel strange, as if I were not real or as if I were cut off from the world". Participants respond on frequency of each statement, ranging from 0 (never) to 5 (all the time), and the duration of this experience, ranging from 1 (few seconds) to 6 (more than a week). Four scores are calculated: number of items endorsed (0-29), average frequency (0-5), average duration (1-6), and a total score calculated by summing scores for both frequency and duration, ranging from 0 to 319. For alienation from surroundings (9 items 0-99), anomalous subjective recall (6 items 0-66), emotional numbing (5 items 0-55) and anomalous body experience (4 items 0-44). Psychometrics and further details of all measures can found in the protocol paper (Wright et al., 2018). The state version includes 22 items measuring anomalous self-experiences in a 'here and now' rating. Participants respond on a visual analogue scale from 0-100. Scores range from 0 to 2200.

Anomalous perceptual experiences: Multimodal Unusual Sensory Experiences Questionnaire (Mitchell et al., 2017) is a 43-item scale measuring anomalous perceptual/sensory experiences with 6 subscales: auditory ("My ears have played tricks on me"), visual, smell, taste, bodily sensations, and sensed presence. Participants are asked to respond to the statements on a 5 point likert scale from never (0) to frequently (4). Scores are totaled for each modality (auditory [0-28], visual [0-32], smell [0-32], taste [0-32], bodily sensations [0-32], and sensed presence [0-16]). MUSEQ total score is obtained by summing all the subscale scores (0-172). The auditory subscale (7 items 0-28), visual subscale (8 items 0-32) and total score was used.

Anomalous (delusional) beliefs: Schizotypal Symptom Inventory (Hodgekins et al., 2012). This is a 20-item measure assessing subthreshold psychotic symptoms which provides a total score with separate subscales for paranoia, anomalous experience and social anxiety (Hodgekins et al., 2012). Participants are asked to rate statements or questions on a five-point Likert scale to assess the recent frequency of each item (0 = not at all, 1 = occasionally, 2 = sometimes, 3 = often, 4 = all of the time). Scores on the SSI range from 0 to 296. This study used the paranoia subscale [6 items 0-24 (e.g. "I often feel that others have it in for me")].

2.4.2 Recovery outcome

The Questionnaire of Process of Recovery (Neil et al., 2009) is a 22-item self-report questionnaire which provides a score for an individual's subjective recovery outcomes: hope, empowerment, confidence, connectedness with others, and reliance (psychosis participants only). The participant rates declarative statements from 0 (strongly disagree) to 4 (strongly agree) with a higher score indicating greater recovery. This measure was used to demonstrate the stage of recovery of the FEP participants. Studies have reported scores in the range of 50-60 for schizophrenia samples (Morrison et al., 2013; Neil et al., 2009).

2.4.3 Symptom measure

Positive and Negative Syndrome Scale (Kay & Fiszbein, 1987) (clinical participants only) is a standardised instrument for assessing symptom severity in schizophrenia (Hermes, Sokoloff, Stroup, & Rosenheck, 2012). This measure provides three separate scores for positive and negative symptoms and general psychopathology.

2.4.4 Perceptual biases and metacognitive efficiency

Experimental tasks were programmed in MATLAB using Cogent 2000. The task stimuli were presented on a Dell laptop and participants wore headphones for the auditory stimulus presentation.

Visual paradigm

Visual perceptual biases and metacognitive efficiency was assessed using a computerised visual detection task. The task involved reporting whether a Gaussian dot flashed in the middle of the screen within a display of moving visual noise. The participants were given a verbal explanation of the task and shown a demonstration. The experimental trials began with the presentation of a central fixation cross on a grey background followed by the presentation of moving static noise for 3000ms. In the stimulus present trials only, at a random time during the 3000ms display of moving noise, the Gaussian dot was flashed in the middle of the screen. The contrast of the dot was titrated for each participant at ~67% correct responses, using a staircase procedure which adjusted the dot contrast with a standardized starting contrast. Participants were told the probability of the target being present would be 50%. Participants had up to 3000ms to make a decision (present or absent) before the program timed out. No feedback was given. Participants were then asked to indicate either high or low confidence decision (see figure 2).

[INSERT FIGURE 2]

The first judgment captured hits (positive responses given when the stimulus was present), false alarms (positive responses given when the stimulus was absent), misses (negative responses when the stimulus was present), and correct rejections (negative responses when the stimulus was absent). This was used to calculate perceptual sensitivity (*d'*): the ability to correctly report the stimulus (dot/tone) as either present or absent. A higher perceptual sensitivity score suggested better ability to detect the stimulus. These four scores can also be used to calculate perceptual bias (B): the tendency to report one decision over the other, i.e. stating the stimuli was present when it was in fact absent, or vice versa. A perceptual bias score was calculated according to Bentall and Slade (1985). A score below 1 suggests a bias towards reporting presence when absent and a score above 1 suggests a bias towards reporting absent of stimuli when present. Equally, the second judgment captures the same four scores for confidence which can be used to calculate a score for metacognitive sensitivity (meta-*d'*): the ability to discriminate between correct and incorrect judgments. Meta-*d'* greater or less than *d'* indicates metacognition is better or worse than d' (Morales et al., 2018). Metacognitive efficiency involves taking into account objective performance (Fleming & Lau, 2014; Maniscalco & Lau, 2012), and is calculated as meta-*d'*-*d'* (metacognitive sensitivity minus perceptual sensitivity) (Rounis, Maniscalco, Rothwell, Passingham, & Lau, 2010).

Auditory paradigm

Auditory detection task was matched with the visual paradigm in terms of structure, number of trials and procedure. The trials began with a presentation of auditory white noise for 3000ms. In the stimulus present trials only, at a random time during the white noise, a brief tone was presented. The volume of the tone was titrated at ~67% correct. Participants responded whether the tone was present or absent and rated their confidence in that decision (high/low confidence) (see figure 3). Perceptual sensitivity/biases and metacognitive sensitivity/efficiency scores were also derived from this auditory task.

[INSERT FIGURE 3]

2.5 Planned analysis

Firstly, we will assess group differences in the two signal detection tasks (e.g. perceptual sensitivity and bias, and metacognition) between individuals with psychosis and healthy controls. A correlational matrix assessed the relationship between the anomalous self- and perceptual experiences and delusional beliefs within the full sample. As an additional analysis, a mediation model was used to explore the indirect relationship between anomalous self-experience and anomalous (delusional) beliefs to confirm this hierarchical framework. Next, correlational analysis were used to assess the relationship between perceptual biases, metacognition sensitivity/efficiency and the anomalous experience/beliefs measures. A Bonferroni-corrected p-value accounted for multiple comparisons. The data was then split by group to assess any potential differences between the FEP and healthy control groups. Multiple regression analyses were conducted to assess the role of perceptual biases in anomalous experiences/beliefs, whilst controlling for perceptual sensitivity.

3. Results

3.1 Sample characteristics

Data was analyzed from 58 FEP and 72 healthy control participants. Thirty-eight FEP participants were using psychotropic medication.

[INSERT TABLE 1]

3.2 Anomalous experience measures

A correlation matrix was created for association between anomalous self- and perceptual experiences and delusional beliefs measures in the full sample (see table 2).

[INSERT TABLE 2]

3.3 Mediation model

A mediation analysis was conducted using Mplus with Multiple Mediation Model (structural equation modelling) using Maximum Likelihood Estimation (MLE), bootstrapping and corrected confidence intervals, following Preacher and Hayes (2008) causal steps of mediation. This mediation model was used to identify the indirect mediating effect of anomalous perceptual experiences between anomalous self-experience and anomalous (delusional) beliefs within the full sample. All scores were converted to z scores using sample means and standard deviations. Significant direct pathways were found between anomalous self-experience and anomalous perceptual experience ($\beta=.64$, $p<.001$) and anomalous perceptual experiences and anomalous (delusional) beliefs ($\beta=.5$, $p<.001$). Anomalous perceptual experiences significantly and fully mediated the relationship between anomalous self-experiences and anomalous (delusional) beliefs ($\beta = .32$, $p<.001$, ±95% CI [0.19, 0.45]). The pathway between anomalous self-experience and anomalous delusional beliefs was non-significant ($p>.05$) (see figure 4).

Using the same process, we examined these relationships within the FEP group. Significant direct pathways were found between anomalous self-experience and anomalous perceptual experience ($\beta=.59$, $p<.001$) and anomalous perceptual experiences and anomalous (delusional) beliefs ($\beta=.65$, $p<.001$). Anomalous perceptual experiences significantly and fully mediated the relationship between anomalous self-experiences and anomalous (delusional) beliefs ($\beta = .39$, $p<.001$, ±95% CI [0.19, 0.6]). The pathway between anomalous self-experience and anomalous delusional beliefs was non-significant ($p>.05$).

Using the same process, we examined these relationships within the healthy control group. Significant direct pathways were found between anomalous self-experience and anomalous perceptual experience ($\beta=.74$, $p<.001$), anomalous self-experience and anomalous delusional beliefs ($\beta=.33$, $p=.01$), and anomalous perceptual experiences and anomalous (delusional) beliefs ($\beta=.27$, $p=.02$). Anomalous perceptual experiences partially mediated the relationship between anomalous self-experiences and anomalous (delusional) beliefs ($\beta = .19$, $p=.02$, ±95% CI [0.03, 0.35]).

[INSERT FIGURE 4]

For the auditory task, participants who scored within 1.5 SD of the mean were included (61-71% correct), a limit used previously in metacognitive studies (Sherman, Seth, Barrett, & Kanai, 2015). This excluded 13 participants from analysis (7 FEP and 6 controls). For the visual task, participants who scored within 2 SD of the mean were included (61-71% correct). This excluded 6 participants from analysis (4 FEP and 2 controls). Visual and auditory tasks were analyzed separately.

3.4 Comparison between groups

Table 3 reported ANOVAs used to assess the differences in perceptual sensitivity, bias, metacognitive sensitivity and efficiency across FEP and healthy control groups.

[INSERT TABLE 3]

There were no significant differences in the perceptual biases and sensitivity, and metacognitive efficiency measures (table 3).

3.5 Associations between perceptual biases, metacognition and anomalous experiences

[INSERT TABLE 4]

[INSERT TABLE 5]

To identify any potential differences in these associations between the clinical and non-clinical groups, we split the data and re-assessed the correlations (FEP and healthy control group).

[INSERT TABLE 6]

As there were no significant associations in the healthy control group. The following data will be presented in the FEP group only.

After multiple comparison correction, there was a significant negative relationship between CDS state with auditory perceptual biases in FEP. Following this, a stepwise regression analysis was conducted with auditory perceptual bias (independent variable) and CDS state score (dependent variable), with auditory perceptual sensitivity as a covariate, in the FEP group only. Even when controlling for auditory perceptual sensitivity, this model was significant and explained 15.5% of the variance in CDS scores, R=.25, [adjusted r^2 .21], F(2, 38) 5.97, p=.01). Auditory perceptual biases predicted a significant change in CDS state score, (ΔR^2=.16, F(1, 36) 7.45 p=.01; see table 7). As the perceptual bias measure is negatively scored, this result demonstrates that increased perceptual biases towards rating 'present' was associated with increased CDS state measure scores.

As there was a significant negative relationship between CDS trait with auditory perceptual biases in FEP (table 6), further analyses were conducted to assess the associations with individual subscales of CDS trait measure (table 8). After multiple comparisons, there was a significant negative relationships between auditory perceptual bias and CDS anomalous bodily experiences (ABE), CDS emotional numbing (EN), and CDS alienation from surroundings (AFS) in the FEP sample.

Three stepwise regression analyses were used to assess the association between auditory perceptual bias and CDS anomalous bodily experiences (ABE), CDS emotional numbing (EN) and CDS alienation from surroundings (AFS), independent of auditory perceptual sensitivity.
For CDS ABE, when controlling for auditory perceptual sensitivity, this model was non-significant (p=.07). For CDS EN, even when controlling for auditory perceptual sensitivity, this model was significant and explained 14.2% of the variance in CDS EN scores, R=.14, [adjusted r^2 .10], F(2, 47) 3.73, p=.03, CI -22.9,-1.67). Auditory perceptual biases predicted 10% of this variance and improved the model (ΔR^2= .1, F(1, 45) = 5.44, p=.022). For CDS AFS, even when controlling for auditory perceptual sensitivity, this model was significant and explained 21% of the variance in CDS AFS score, R=.21, [adjusted r^2 .17], F(2, 47) 5.96, p=.01, CI -23.58,-3.94). Auditory perceptual biases predicted 14% of this variance and improved the model (ΔR^2= .14, F(1, 45) = 7.96, p=.01)

4. Discussion

This experimental cross-sectional study demonstrated that auditory perceptual biases (a lower threshold for accepting an auditory stimulus as present) was associated with increased state and trait anomalous self-experiences (within this study, depersonalization and, specifically, alienation from surroundings and emotional numbing) in the full sample, but specifically in the FEP group.

A perceptual bias towards noticing a stimuli as present (within the environment) may be closely linked with the phenomenological concept of hyperreflexivity (heightened awareness of aspects of experience that are normally implicit (Sass et al., 2018) and the neurocognitive concept of aberrant salience (Kapur, 2003). Therefore, an individual who has a lower threshold for noticing auditory stimulus within the environment may be overly aware of themselves or their environment, which means aspects of these domains are overly salient. For example, a lower threshold for detecting a signal (message) from meaningless noise was previously demonstrated in those deemed as Ultra-High Risk (UHR) and who later transitioned to psychosis (Hoffman et al., 2007). This hypervigilance and hyperawareness of stimuli can alienate the individual, leave them feeling detached and experience difficulty identifying themselves from their environment (alienation from surroundings). From this hyperawareness, the individual may feel an information overload and as a consequence they “shut-down” their emotions to these anomalous experiences (emotional numbing), i.e. as a compensatory mechanism to avoid distress.

Recently, Powers, Mathys and Corlett (2017) demonstrated the role of top-down cognitive biases, via predictive processing models, on auditory hallucinations in clinical participants. In a response to Powers et al. (2017), Nelson and Hartmann (2017) suggested that predictive processing models could explain disturbance of the “minimal” self; in this case, dissociation. The use of predictive processing to understand self-disturbance has been suggested by Clowes et al. (2017) as imprecise predictions must be explained, which may lead to hyperreflexivity and, therefore, dissociation (Seth, 2013; Seth, Suzuki, & Critchley, 2012). Difficulties with biases may lead to hyperreflexivity; heightened awareness to aspects of experience that are normally implicit (Nelson et al., 2014a, 2014b), which can undermine an individual’s sense of being grounded within a shared universe and is likely to alienate the self, leading to the anomalous self-experiences (see Sass et al., 2018).

Both perceptual biases and anomalous self-experiences may be considered low-level or sub-conscious (e.g. not involving higher-level cognitive appraisals). However, contrary to previous research (Moritz, Woodward, Jelinek, & Klinge, 2008; Moritz et al., 2017; Veckenstedt et al., 2011), this study did not demonstrate significant group differences in perceptual biases for those with FEP and those in the healthy control group. In this sample, individuals with FEP had fewer symptoms, including subclinical level hallucinations and similar scores on anomalous experiences (MUSEQ) as the healthy control group and better functioning compared to other FEP and schizophrenia studies (Fitzgerald et al., 2004; Hodgekins et al., 2015; Leucht et al., 2005), which may suggest that the FEP group may have been further along in their recovery and may be able to more accurately reflect on their experiences, supporting the presence of seemingly intact metacognitive efficiency.

Despite limited differences between the groups, only those within the FEP group demonstrated the association between propensity to perceptual bias associated with a vulnerability to experience anomalous self-experiences, suggesting that in FEP when perceptual biases are present they are likely to co-occur or be associated with anomalous self-experiences. This underlying, low-level relationship between perceptual biases and anomalous self-experiences may have been easier to capture as it was not confounded by positive symptoms. Later, this association may lead to hallucinations. The groups, however, did differ on the presence of state anomalous self-experiences, suggesting that those with FEP were experiencing high levels of state anomalous self-experiences in the moment during the assessments, compared to healthy controls. It is possible that the level of state anomalous experience may have impacted on one's performance and hence the association with perceptual biases. This may be explained by, as suggested in the introduction, aberrant salience hypotheses in that an individual may have been more distracted or less able to focus attention due to additional environmental stimuli, leading to perceptual biases and dissociative experiences in the moment. This is a tentative hypothesis and future studies should aim to assess this with a more robust model using larger samples.

The mediation model demonstrated that anomalous self-experiences are associated with perceptual experiences which are, in turn, associated with anomalous delusional beliefs. Once one takes into account the relationship between anomalous self-experiences and anomalous perceptual experiences, there is no direct pathway between anomalous self-experiences and delusional beliefs in the FEP group, specifically. This suggests that anomalous self-experiences may lead to surface-level anomalous perceptual experiences (Varese et al., 2011; Nelson, Parnas & Sass, 2014) which, through the process of cognitive appraisal, may develop into higher-level (delusional) beliefs (Garety et al., 2001; Freeman et al., 2002). In the healthy control group only, there was a direct pathway between each component. Additional research needs to be conducted utilizing experimental or longitudinal designs to test this possible causal relationship.

Contrary to the literature, perceptual biases were not associated with anomalous perceptual experiences. Haarsma et al. (2018) demonstrated strong evidence for weakened perceptual priors in ARMS group, compared to FEP and healthy controls. But stronger cognitive priors in the FEP group, compared to ARMS and healthy controls. Haarsma et al. suggested that high-level cognitive priors may develop from weak low-level priors as a compensation (see Adams et al., 2013; Heinz et al., 2018; Sterzer et al., 2018). Future studies could aim to examine differences in these variables of interest in groups of individuals at various stages of their recovery or longitudinal across their recovery.

Of importance here is that metacognitive efficiency was not associated with any of these anomalous experiences or beliefs. As suggested above, these individuals with FEP had fewer symptoms and both groups had intact metacognitive efficiency. It may be suggested that, when more symptomatic in psychosis, metacognitive efficiency may have a key role in anomalous experiences/beliefs. Assessing these variables across clinical groups will enable detection of core difficulties at different stages of illness to identify which factors are the main triggers of anomalous experiences. Associated with this, this lack of association with anomalous perceptual experiences/delusional beliefs may be because individuals within this FEP sample were currently, or recently, involved within the Early Intervention Service (EIS) which provides pharmacological (typically, antipsychotic medication to reduce the salience of anomalous experiences; Kapur, 2003) or psychological interventions (typically, CBT-p to alter the response to anomalous experiences and prevent maintenance of anomalous delusional beliefs; Birchwood & Trower, 2012). CBT-p has shown positive effects (Gould et al., 2015; Tarrier et al., 1998; Turner, Van Der Gaag, Karyotaki, & Cuijpers, 2014), and may have a role in improving metacognitive capacities, as recently evidenced by metacognitive training, which has focused on changing faulty cognitive processes (Moritz et al., 2014); metacognitive therapy, based on changing beliefs about thoughts from Metacognitive Therapy for emotional distress (Wells & Matthews, 1994; Wells & Matthews, 1996) and shown to have a significant effect on reducing positive symptoms for those with schizophrenia spectrum disorders (Morrison et al., 2014); and metacognitive reflection and insight therapy (de Jong et al., 2018; Lysaker, Gagen, Moritz, & Schweitzer, 2018) or metacognitive interpersonal therapy (Dimaggio, Salvatore, Buonocore, Popolo, & Ottavi, 2018; Salvatore et al., 2012) focused on building a personal narrative for metacognitive reflection. Early Intervention Services within the UK offer CBTp and, whilst this study did not assess the use of this therapy, CBTp may be usefully integrated with metacognitive training within current services. Such integrated therapy trials could explore the possibility of improving metacognitive deficits in FEP and the association with reduction in psychotic experiences.

Another reason may be the assessment of metacognition as this paper assessed metacognitive efficiency for perceptual experiences; a low-level metacognitive process which are inherently difficult to capture and, therefore, requires more experimental control during the assessment compared to other studies. Because of the additional control, it may be difficult to identify aspects of experience of psychosis which are specifically related to metacognitive efficiency using this measure. Alternatively, it is important to consider the alternative argument that metacognitive efficiency may not be associated with anomalous experiences. A small number of studies have assessed metacognitive efficiency, using meta-*d'*, and demonstrated limited association with brain function or psychotic symptoms in psychosis and healthy controls (Corcoran, Groot, Bruno, Johnston, & Cropper, 2018; Davies et al., 2018; Powers et al., 2017a). Future studies should aim to further develop this measure of metacognition, examining the reliability and validity, before its further application in a clinical group. In comparison, other studies have considered metacognitive processes at a higher order level and their impact on anomalous experiences (McLeod, Gumley, MacBeth, Schwannauer, & Lysaker, 2014; Morrison et al., 2011; Salvatore et al., 2012) and function (Lysaker et al., 2010; Wright, Davies, Fowler, & Greenwood, 2019; Wright, Mueser, McGurk, Fowler, & Greenwood, 2019), suggesting higher-order metacognition may, instead, have a specific role in psychosis or psychotic experiences.

4.1 Limitations

There are limitations to the study. Firstly, using the current cross-sectional design, it is not possible to explore triggers of anomalous experiences. Future studies could aim to use designs that experimentally induce a perceptual bias (see Powers, Mathys, & Corlett, 2017b), and assess how metacognition and anomalous experiences vary in response, allowing stronger inferences regarding causality, or adopt a longitudinal design involving follow up and repeated assessments over time. Secondly, many participants were biased towards the stimuli being absent, showing a strict and conservative approach to accepting the stimuli as present. For the FEP group, the progressed stage of their recovery may explain their conservative approach. In addition, we had to remove a number of participants for performing too high or too low. This may be due to a number of possibilities, including lack of concentration, difficulty in understanding the task instructions, or clinical difficulties. Future studies could aim to examine differences in performance in groups of individuals at various stages of their recovery or longitudinal across their recovery. Thirdly, the study demonstrated an association within only the auditory modality. Auditory anomalous experiences were slightly higher than other modalities, in support of current research in psychosis (McCarthy-Jones et al., 2017; Shergill, Murray, & McGuire, 1998; Waters et al., 2012). This modality-specific result may be an effect of the nature of the experience. Future studies could explore this within individuals with or without auditory hallucinations compared to other modalities. Fourthly, this study used only cross-sectional data and self-report measures may be highly intercorrelated due to method variance. Future studies should aim to assess these experiences across time, within a longitudinal design. Whilst this study excluded individuals from the healthy control group if they reported current or family history of mental health or use of medication, mental health can fluctuate and can go undiagnosed so there is potential for the group to have had historical difficulties which were not captured by these questions. Future research should aim to replicate this study by using more rigorous assessments, e.g. Mini International Neuropsychiatric Interview (MINI). Finally, educational level was significantly different between the groups, a previous confound in metacognition measures (Gaweda et al., 2013; Moritz et al., 2014). Whilst this study aimed to match participants on education level, individuals with psychosis were less likely to have completed A-Level qualifications than the healthy control group which resulted in a significant difference in education level. However, it should be highlighted that IQ was not significantly different between the groups, which may have reflected the age of onset of psychosis. This is a more detailed measure of academic performance. Future studies should use IQ as a measure of comparison, rather than educational level which may not be best suited to capture ability.

5. Conclusion

This study identified increased auditory perceptual biases were associated with increased anomalous self-experiences - in particular, alienation from surroundings and emotional numbing in FEP. Anomalous self-experiences which are associated with perceptual biases and may be the underlying causal vulnerability of anomalous perceptual experiences, which can be particularly distressing and disorienting. This study demonstrated auditory perceptual biases may represent an early causal vulnerability for anomalous self-experiences. This may be a therapeutic target for those with anomalous-self experiences to prevent initial or re-occurrence of anomalous perceptual experiences and delusional beliefs.

6. References

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Ethical standards

Ethical and Health Research Authority approval was obtained through Camberwell St. Giles Research Ethics Committee (reference number: 17/LO/0055).

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Conflict of interest statement

There is no conflict of interest.

Figure legends

Figure 1: Proposed theoretical model for the associations between anomalous self- and perceptual experiences, anomalous delusional beliefs, perceptual biases and metacognitive efficiency.

Figure 2: Visual detection metacognitive paradigm.

Figure 1: Auditory detection metacognitive paradigm.

Figure 4: Mediation model for anomalous self-experiences, anomalous perpetual experiences and anomalous (delusional) beliefs within the full sample (N=130).

Tables

Table 1: Sample characteristics and descriptive statistics summary table.

	FEP (N=58)	**Healthy Control (N=72)**	**Difference tests**
Age, yrs. (SD)	27.17 (S.D 1.3) range 18-43	25.7 (S.D 6.6) range 18-40	t(128) -1.34,p=.18
Gender M/F (% males)	42/16 (72%)	51/21 (71%)	χ^2 (1, N = 128) = .04, p=.84
Education (level, %)	No qualifications-GCSE: 33% A-levels: 37% Degree or higher: 30%[1]	No qualifications-GCSE: 8% A-levels: 64% Degree or higher: 28%	**χ^2 (2, N = 129) = 14.79, p=.01**
2-part IQ	105.32 (S.D 14.9)	106.2 (S.D 10.75)	t(124) -.38, p=.7
MUSEQ Auditory $^{(0-28)}$	19.2 (7.2)	17.9 (5.64)	t(106.06) 1.21, p=.24, *d*=.2

[1] Due to the way educational level was measured and the assumptions of Chi-Square tests, we had to collapse the groups into GCSE (no qualifications or GCSE-level), A-levels, Degree (degree or higher degree). 1 FEP participant preferred not to state but this was removed from this analysis.

MUSEQ Visual (0-28)	18.3 (8.0)	16.7 (5.8)	t(100.7) 1.37 p=.17, *d*=.22
MUSEQ full total (0-172)	89.7 (34.8)	86.0 (26.2)	t(128) .69, p=.49, *d*=.12
CDS trait total (0-319)	49.95 (45.2)	40.7 (28.9)	t(93.0) 1.41, p=.16, *d*=.24
CDS state total (0-2200)	185.9 (255.5)	87.4 (125.2)	**t(77.12) 2.87, p=.01,** *d*=.49
CDS trait ABE (0-44)	11.2 (13.8)	8.9 (9.11)	t(94.92) 1.09, p=.28, *d*=.2
CDS trait EN (0-55)	10.9 (10.4)	8.89 (7.8)	t(128) 1.28, p=.2, *d*=.22
CDS trait ASR (0-66)	10.6 (8.9)	8.96 (6.6)	t(103.2) 1.17, p=.24, *d*=.24
CDS trait AFS (0-99)	10.6 (10.1)	7.9 (6.0)	t(88.3) 1.83, p=.07, *d*=.33
SSI paranoia (0-24)	12.98 (6.0)	11.1 (4.0)	**t(95.5) 2.05, p=.04,** *d*=.37
SSI anomalous experiences (0-32)	15.4 (7.5)	12.5 (4.8)	**t(92.1) 2.5, p=.01,** *d*=.45
SSI social anxiety (0-24)	16.03 (6.81)	12.89 (4.9)	**t(100.96) 2.95, p=.01,** *d*=.53
Questionnaire of Process of Recovery (0-88)	61.7 (13.3)	N/A	N/A
PANSS positive (7-49)	12.4 (4.7)	N/A	N/A
PANSS negative (7-49)	11.5 (4.0)	N/A	N/A
PANSS general psychopathology (16-112)	26.7 (5.7)	N/A	N/A

PANSS hallucinations (1-7)	2.12 (1.45)	N/A	N/A

MUSEQ = Multimodal Unusual Sensory Experiences Questionnaire; CDS = Cambridge Depersonalisation Scale; ABE = Anomalous Bodily Experiences; EN = Emotional Numbing; ASR = Anomalous Subjective Recall; AFS = Alienation From Surroundings; SSI = Schizotypal Symptom Inventory; PANSS = Positive And Negative Syndrome Scale. **Bold**: These ANOVAs were significant.

Table 2: Correlation matrix for associations between anomalous experiences measures in the full sample.

N=130	MUSEQ Auditory	MUSEQ Visual	MUSEQ Total	CDS state total	CDS trait total	CDS anomalous bodily experience	CDS emotional numbing	CDS anomalous subjective recall	CDS alienation from surroundings	SSI Paranoia	SSI Anomalous experiences
MUSEQ Auditory	1	**r=.77 p<.001**	**r=.81 p<.001**	**r=.43 p<.001**	**r=.54 p<.001**	**r=.43 p<.001**	**r=.47 p<.001**	**r=.52 p<.001**	**r=.49 p<.001**	**r=.54 p<.001**	**r=.56 p<.001**
MUSEQ Visual		1	**N/A**	**r=.44 p<.001**	**r=.56 p<.001**	**r=.55 p<.001**	**r=.46 p<.001**	**r=.46 p<.001**	**r=.48 p<.001**	**r=.54 p<.001**	**r=.65 p<.001**
MUSEQ Total			1	**r=.48 p<.001**	**r=.64 p<.001**	**r=.58 p<.001**	**r=.55 p<.001**	**r=.58 p<.001**	**r=.5 p<.001**	**r=.57 p<.001**	**r=.65 p<.001**
CDS state total				1	**r=.6 p<.001**	**r=.5 p<.001**	**r=.47 p<.001**	**r=.55 p<.001**	**r=.57 p<.001**	**r=.43 p<.001**	**r=.59 p<.001**
CDS trait total					1	N/A	N/A	N/A	N/A	**r=.45 p<.001**	**r=.49 p<.001**
CDS (trait) anomalous bodily experience						1	**r=.69 p<.001**	**r=.64 p<.001**	**r=.69 p<.001**	**r=.35 p<.001**	**r=.42 p<.001**
CDS (trait) emotional numbing							1	**r=.73 p<.001**	**r=.74 p<.001**	**r=.42 p<.001**	**r=.37 p<.001**
CDS (trait) anomalous subjective recall								1	**r=.66 p<.001**	**r=.48 p<.001**	**r=.58 p<.001**
CDS (trait) alienation									1	**r=.38 p<.001**	**r=.44 p<.001**

from surroundings		
SSI Paranoia	1	**r=.6 p<.001**

Note: MUSEQ = Multimodal Unusual Sensory Experiences Questionnaire; CDS = Cambridge Depersonalisation Scale; SSI = Schizotypal Symptom Inventory.

Table 3: Descriptive statistics for the two signal detection tasks, with difference tests.

	FEP sample (visual: N=50; auditory: N=47)	Healthy control sample (N=68)	Difference tests
Visual perceptual sensitivity[2]	1.25 (S.D .33)	1.09 (S.D .39)	$F(1, 117)= 3.65$, $p=.06$, *d*= .44
Visual perceptual bias (increased score = bias towards absent)[3]	.76 (S.D .35)	.74 (S.D .38)	$F(1, 117)= .97$, $p=.33$, *d*=.05
Visual metacognitive sensitivity	.69 (S.D .42)	.78 (S.D .37)	$F(1, 117)= .09$, $p=.77$, *d*=.22
Visual metacognitive efficiency	-.56 (S.D .5)	-.41 (S.D .5)	$F(1, 117)= 2.53$, $p=.12$, *d*=.3
Auditory perceptual sensitivity	1.11 (S.D .42)	1.19 (S.D .39)	$F(1, 113)= .05$, $p=.8$, *d*=.19
Auditory perceptual bias	.77 (S.D .47)	.72 (S.D .45)	$F(1, 113)= .28$, $p=.6$, *d*=.11
Auditory metacognitive sensitivity	.66 (S.D .44)	.67 (S.D .31)	$F(1, 113)= .34$, $p=.56$, *d*=.03
Auditory metacognitive efficiency	-.46 (S.D .52)	-.40 (S.D .41)	$F(1, 113)= .39$, $p=.54$, d=.13

[2] Due to threshold, For the auditory task, participants who scored within 1.5 SD of the mean were included (61-71% correct), a limit used previously in metacognitive studies (Sherman et al., 2015). This excluded 13 participants from analysis (7 FEP and 6 controls). For the visual task, participants who scored within 2 SD of the mean were included (61-71% correct). This excluded 6 participants from analysis (4 FEP and 2 controls). There were no differences in the number of people excluded from each group for either of the tasks. ($p>.05$).

[3] Twenty-four participants (9 FEP and 15 controls) had a perfect score on absent trials, implying an infinite d'. We converted proportions of 0 and 1 to $1/(2N)$ and $1-1/(2/N)$, respectively, where N is the number of trials on which the proportion is based; following recommended research (Macmillan & Creelman, 2005).

Table 4: Correlational matrix for association between visual signal detection task measures and anomalous experiences in full group.

N=114	Visual perceptual sensitivity	Visual perceptual bias	Visual metacognitive sensitivity	Visual metacognitive efficiency	MUSEQ visual	MUSEQ auditory	MUSEQ total	CDS trait	CDS state	SSI paranoia
Visual perceptual sensitivity	1	**r= .81*** p<.001**	r= .11 p=.24	**r= -.64*** p<.001**	r= -.15 p=.11	r= .02 p=.88	r= .19* p=.041	r= -.18 p=.06	r= -.12 p=.21	r= -.02 p=.87
Visual perceptual bias		1	r= .13 p=.15	**r= -.48*** p<.001**	r= -.09 p=.33	r= -.04 p=.66	r= -.1 p=.3	r= -.12 p=.19	r= -.04 p=.7	r=.06 p=.51
Visual metacognitive sensitivity			1	N/A	r= -.01 p=.91	r= .14 p=.14	r= -.07 p=.48	r= -.14 p=.13	r= -.07 p=.43	r= -.11 p=.23
Visual metacognitive efficiency				1	r= .06 p=.5	r= .1 p=.32	r= .05 p=.6	r= -.01 p=.88	r= -.04 p=.7	r= -.11 p=.25

MUSEQ = Multimodal Unusual Sensory Experiences Questionnaire; CDS = Cambridge Depersonalisation Scale; SSI = Schizotypal Symptom Inventory. Bold: These correlations held after multiple comparison correction.

After correcting for multiple comparisons, there were no significant associations between visual perceptual biases or metacognitive efficiency with anomalous self- or perceptual- experiences nor with anomalous (delusional) beliefs. No further analyses were conducted.

Table 5: Correlational matrix for association between auditory signal detection task measures and anomalous experiences in full group.

N=114	Auditory perceptual sensitivity	Auditory perceptual bias	Auditory metacognitive sensitivity	Auditory metacognitive efficiency	MUSEQ Auditory	MUSEQ Visual	MUSEQ Total	CDS Trait	CDS State	SSI Paranoia
Auditory perceptual sensitivity	1	**r= .79*** p<.001**	**r= .3*** p<.001**	**r= -.64*** p<.001**	r= .02 p=.9	r= .04 p=.68	r= -.03 p=.73	r= -.19* p=.04	r= -.21* p=.03	r= .08 p=.41
Auditory perceptual bias		1	**r= .24* p=.01**	**r= -.51*** p<.001**	r= -.04 p=.72	r= -.04 p=.7	r= -.13 p=.19	**r= -.27** p=.004**	**r= -.3** p=.001**	r= .03 p=.73
Auditory metacognitive sensitivity			1	N/A	r= .13 p=.17	r= .06 p=.53	r= .04 p=.66	r= -.19* p=.05	r= -.16 p=.09	r= .18 p=.06
Auditory metacognitive efficiency				1	r= .1 p=.32	r= .01 p=.93	r= .06 p=.51	r= .02 p=.84	r= .05 p=.61	r= .11 p=.24

MUSEQ = Multimodal Unusual Sensory Experiences Questionnaire; CDS = Cambridge Depersonalisation Scale; SSI = Schizotypal Symptom Inventory. Bold: These correlations held after multiple comparison correction.

Table 6: Correlational matrix for associations between auditory signal detection task measures and anomalous experiences in FEP group only.

N=48	Auditory perceptual sensitivity	Auditory perceptual bias	Auditory metacognitive sensitivity	Auditory metacognitive efficiency	MUSEQ Auditory	MUSE Q Visual	MUSE Q Total	CDS Trait	CDS State	SSI Paranoia
Auditory perceptual sensitivity	1	**r= .81*** p<.001**	r= .27 p=.06	**r= -.59*** p<.001**	r= .02 p=.9	r= .001 p=.99	r= -.13 p=.4	r= -.3* p=.04	r= -.31 p=.06	r= .06 p=.71
Auditory perceptual bias		1	**r= .3* p=.04**	**r= -.41*** p=.004**	r= -.04 p=.81	r= -.09 p=.54	r= -.24 p=.11	**r= -.43** p=.002**	**r= -.48** p=.002**	r= .12 p=.41
Auditory metacognitive sensitivity			1	N/A	r= .16 p=.29	r= .09 p=.55	r= .03 p=.87	r= -.22 p=.13	r= -.27 p=.09	r= .17 p=.25
Auditory metacognitive efficiency				1	r= .15 p=.32	r= .07 p=.62	r= .12 p=.41	r= .05 p=.73	r= .01 p=.96	r= .1 p=.51

MUSEQ = Multimodal Unusual Sensory Experiences Questionnaire; CDS = Cambridge Depersonalisation Scale; SSI = Schizotypal Symptom Inventory. Bold: These correlations held after multiple comparison correction.

Table 7: Regression values to show associations with state anomalous experiences in FEP group.

		B	SE B	B	p value	CI
Model 2						
	Constant	2.26	.29			
	Auditory perceptual sensitivity	.32	.38	.2	.40	-.45, 1.09
	Auditory perceptual bias	-.92	.34	-.64	.01	-1.61, -.24

**= p<.05, **=p<.01*

Table 8: Correlational matrix for the association between auditory perceptual and metacognitive measures and subscales of anomalous self-experiences in the FEP group.

N=48	CDS trait ABE	CDS trait EN	CDS trait ASR	CDS trait AFS
Auditory perceptual sensitivity	**r= -.33*** **p=.02**	r= -.2 p=.19	r= -.18 p=.21	r= -.26 p=.07
Auditory perceptual bias	**r= -.42*** **p=.003**	r= **-.35**** p=**.02**	r= -.3* p=.04	r= **-.43**** p=**.002**
Auditory metacognitive sensitivity	r= -.24 p=.1	r= -.19 p=.2	r= -.17 p=.25	r= -.23 p=.12
Auditory metacognitive efficiency	r= .07 p=.65	r= .001 p=.99	r= .006 p=.97	r= .02 p=.88

Note: CDS = Cambridge Depersonalisation Scale; ABE = Anomalous Bodily Experiences; EN = Emotional Numbing; ASR = Anomalous Subjective Recall; AFS = Alienation From Surroundings. **Bold**: These correlations held after multiple comparison correction.